

Test Report

20-1-0094901T08a



Deutsche
Akkreditierungsstelle
D-PL-12047-01-01
D-PL-12047-01-03
D-PL-12047-01-04

Number of pages: 26 **Date of Report:** 2021-Sep-06

Testing company: CETECOM GmbH
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Applicant: Prodrive Technologies BV

Product: RFID Reader
Model: RFID Reader

FCC ID: Y2IRFIDR **IC:** 9389A-RFIDR

Testing has been carried out in accordance with:

Title 47 CFR, Chapter I
FCC Regulations, Subchapter A
Part 15, Subpart C: §15.225

ANSI C63.10-2020 chapter 6.4/5/8/9

ISED Regulations
RSS-Gen, Issue 5 + Amendment 2
RSS-210, Issue 10

Deviations, modifications or clarifications (if any) to above mentioned documents are written in each section under "Test method and limit".

Tested Technology: RFID

Test Results: ☒ **The EUT complies with the requirements in respect of all parameters subject to the test.**
The test results relate only to devices specified in this document

Signatures:

Dipl.-Ing. Ninovic Perez Test Lab Manager Authorization of test report	M.Sc. Guangcheng Huang Test manager Responsible of test report
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Annex 4	Test set-up photographs	CETECOM_TR20-1-0094901T08a_A4	9
The listed attachments are separate documents.			

1 General information

1.1 Disclaimer and Notes

The test results of this test report relate exclusively to the test item specified in this test report as specified in chapter 2.7. CETECOM does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.

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Also we refer on special conditions which the applicant should fulfill according §2.927 to §2.948, special focus regarding modification of the equipment and availability of sample equipment for market surveillance tests.

1.2 Attestation

I declare that all measurements were performed by me or under my supervision and that all measurements have been performed and are correct to my best knowledge and belief to Industry Canada standards. All of the above requirements are met in accordance with enumerated standards.

1.3 Summary of Test Results

The EUT integrates a RFID-Transceiver working at 125 kHz and 13.56 MHz nominal frequency. The frequency of 125 kHz is not considered within this test report.

Test case	Reference Clause FCC ☒	Reference Clause ISSED ☒	Page	Remark	Result
Radiated field strength emissions and emission mask	§15.225(a)(b)(c)(d)	--	12	--	PASSED
Radiated field strength emissions below 30 MHz	§15.209(a)	RSS-Gen: Issue 5 §8.9 Table 6	16	--	PASSED
Radiated field strength emissions 30 MHz – 1 GHz	§15.209(a)	RSS-Gen: Issue 5 §8.9 Table 5 RSS-247, §5.5	18	--	PASSED
Occupied Channel Bandwidth 99%	§2.202(a) §2.1049(h)	RSS-Gen, Issue 5, §6.6	19	--	PASSED
Frequency stability	§2.1055 §15.225(e)	RSS-Gen: Issue 5: §8.9 Table 5+7 RSS-247, §5.5	21	--	PASSED
AC-Power Lines Conducted Emissions	§15.207	RSS-Gen Issue 5: §8.8, Table 4	--	--	N/A

PASSED

The EUT complies with the essential requirements in the standard.

FAILED

The EUT does not comply with the essential requirements in the standard.

NP

The test was not performed by the CETECOM Laboratory.

N/A

Not applicable

*The calculation of the measurement uncertainty shows compliance with the "maximum measurement uncertainties" of the tested standard and therefore for result evaluation the stated uncertainties will not be additionally added to the measured results.

1.4 Summary of Test Methods

Test case	Test method
Radiated field strength emissions and emission mask	ANSI C63.10-2020
Radiated field strength emissions below 30 MHz	ANSI C63.10-2020; §6.4
Radiated field strength emissions 30 MHz- 1 GHz	ANSI C63.10-2020; §6.5
Occupied Channel Bandwidth 99%	ANSI C63.10-2020; §6.9
Frequency stability tests	ANSI C63.10-2020; §6.8
AC-Power Lines Conducted Emissions	ANSI C63.10-2020; §6.2

And reference also to Test methods in KDB558074

2 Administrative Data

2.1 Identification of the Testing Laboratory

Company name:	CETECOM GmbH
Address:	Im Teelbruch 116 45219 Essen - Kettwig Germany
Responsible for testing laboratory:	Dipl.-Ing. Ninovic Perez
Accreditation scope:	DAkkS Webpage: FCC ISED
Test location:	CETECOM GmbH; Im Teelbruch 116; 45219 Essen - Kettwig

2.2 General limits for environmental conditions

Temperature:	22±2 °C
Relative. humidity:	45±15% rH

2.3 Test Laboratories sub-contracted

Company name:	--
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2.4 Organizational Items

Responsible test manager:	M.Sc. Guangcheng Huang
Receipt of EUT:	2021-Jun-24
Date(s) of test:	2021-Jul-20 – 2021-Aug-11
Version of template:	14.7

2.5 Applicant's details

Applicant's name:	Prodrive Technologies BV
Address:	Science Park Eindhoven 5501 5692 EM Son The Netherlands
Contact Person:	Free Claessens
Contact Person's Email:	free.claessens@prodrive-technologies.com

2.6 Manufacturer's details

Manufacturer's name:	Prodrive Technologies BV
Address:	Science Park Eindhoven 5501 5692 EM Son The Netherlands

2.7 EUT: Type, S/N etc. and short descriptions used in this test report

Short description*)	PMT Sample No.	Product	Model	Type	S/N	HW status	SW status
EUT 1	20-1-00949S04_C02	RFID Reader	RFID Reader	N/A	2110A18CFL	R05	R01
EUT 2	20-1-00949S03_C02	RFID Reader	RFID Reader	N/A	2110A18CHG	R05	R01

*) EUT short description is used to simplify the identification of the EUT in this test report.

2.8 Auxiliary Equipment (AE): Type, S/N etc. and short descriptions

Short description*)	PMT Sample No.	Auxiliary Equipment	Type	S/N	HW status	SW status
AE 1	20-1-00949S05_C01	13.56 MHz RFID tag	N/A	N/A	N/A	N/A
AE 2	--	Laptop	Latitude E6420	--	Intel core i5	Windows 7 Enterprise

*) AE short description is used to simplify the identification of the auxiliary equipment in this test report.

2.9 Connected cables

Short description*)	PMT Sample No.	Cable type	Connectors	Length
CAB 1	20-1-00949S09_C01	Power + RS232 cable	Power, RS232, USB, 4-pin	120 cm
CAB 2	20-1-00949S12_C01	USB cable	USB-A to mini-USB	20 cm

*) CAB short description is used to simplify the identification of the connected cables in this test report.

2.10 Software

Short description*)	PMT Sample No.	Software	Type	S/N	HW status	SW status
SW 1	20-1-00949S10_C01	Termite 3.4				

*) SW short description is used to simplify the identification of the used software in this test report.

2.11 EUT set-ups

set-up no. *)	Combination of EUT and AE	Description
Set 1	EUT 1 + AE 2 + CAB 1 + CAB 2 + SW 1	Used for Radiated measurements. Test mode without RFID tag. AE 02 + SW 01 was used for set-up configuration.
Set 2	EUT 1 + AE 1 + AE 2 + CAB 1 + CAB 2 + SW 1	Used for Radiated measurements. Test mode with RFID tag. AE 02 + SW 01 was used for set-up configuration.
Set 3	EUT 2 + AE 2 + CAB 1 + CAB 2 + SW 1	Used for Radiated measurements. Test mode without RFID tag. AE 02 + SW 01 was used for set-up configuration.
Set 4	EUT 2 + AE 1 + AE 2 + CAB 1 + CAB 2 + SW 1	Used for Radiated measurements. Test mode with RFID tag. AE 02 + SW 01 was used for set-up configuration.

*) EUT set-up no. is used to simplify the identification of the EUT set-up in this test report.

2.12 EUT operation modes

EUT operating mode no. *1)	Operating modes	Additional information
op. 1	TX	EUT intermittent transmission searching for counterpart
op. 2	TXRX	EUT intermittent communication to 13.56 MHz RFID tag AE 1

*1) EUT operating mode no. is used to simplify the test report.

3 Equipment under test (EUT)

3.1 General Data of Main EUT as Declared by Applicant

Product name	RFID Reader		
Kind of product	RFID Reader at 13.56 MHz and 125 kHz (125 kHz not tested within this report)		
Firmware	<input type="checkbox"/> for normal use	<input checked="" type="checkbox"/> Special version for test execution	
Power supply	<input type="checkbox"/> AC Mains	-	
	<input checked="" type="checkbox"/> DC Mains	13.5 V DC via 4-pin Connector	
	<input type="checkbox"/> Battery	-	
Operational conditions	T _{nom} =21 °C	T _{min} =-30 °C	T _{max} =75 °C
EUT sample type	Engineering Samples		
Weight	0.1 kg		
Size [LxWxH]	7.5 cm x 5cm x 2 cm		
Interfaces/Ports	USB		
For further details refer Applicants Declaration & following technical documents			

3.2 Detailed Technical data of Main EUT as Declared by Applicant

Frequency Band	13.553 – 13.567 MHz	
Number of Channels (USA/Canada -bands)	1 nominal at 13.56 MHz	
Nominal Channel Bandwidth	Not reported	
Type of Modulation Data Rate	ASK (amplitude-shift keying)	
Other installed options	RFID Reader at 125 kHz (125 kHz not tested within this report)	
Antenna Type	PCB coil antenna	
Antenna Gain	Not reported	
FCC label attached	No	
Test firmware / software and storage location	EUT	
For further details refer Applicants Declaration & following technical documents		
Description of Reference Document (supplied by applicant)	Version	Total Pages
M2001226324_manualRFID	-	4

3.3 Modifications on Test sample

Additions/deviations or exclusions	--
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4 Measurements

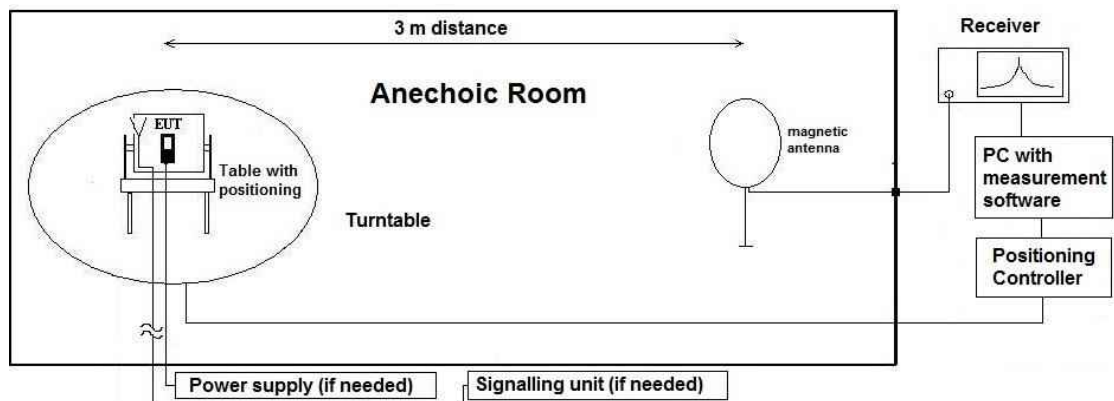
4.1 Radiated field strength emission and mask at 13.110 MHz – 14.010 MHz

4.1.1 Description of the general test setup and methodology, see below example:

Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

Measurement is made using Rohde & Schwarz TS8997 test system.

EUT settings

4.1.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.1.3 Limit

Frequency Range [MHz]	Limit [μV/m]	Limit [dBμV/m]	Detector	RBW [kHz]	Remark
13.553 – 13.567	15.848	84	PEAK	10	PEAK, TRACE max-hold mode, repetitive scan for exploratory measurements Quasi-Peak, for final measurement on critical frequencies (f<1GHz)
13.410 – 13.553 and 13.567 – 13.710	334	50.47			
13.110 – 13.410 and 13.710 – 14.010	106	40.5			
$f \leq 13.110 - 14.010 \geq f$	30	29.5			

4.1.4 Result

Diagram	Channel	Mode	Remark	Result
2.05	1	Op. 1 TX standing	Max. value: 36.737 dB μ V/m	Passed
2.02	1	Op. 1 TX laying	Max. value: 26.258 dB μ V/m	Passed
2.06	1	Op. 2 TXRX standing	Max. value: 32.709 dB μ V/m	Passed
2.04	1	Op. 2 TXRX laying	Max. value: 25.893 dB μ V/m	Passed

Remark: for more information and graphical plot see annex **CETECOM_TR20_1_0094901T08a_A1**
Further tests are only performed on EUT standing orientation because of worst case.

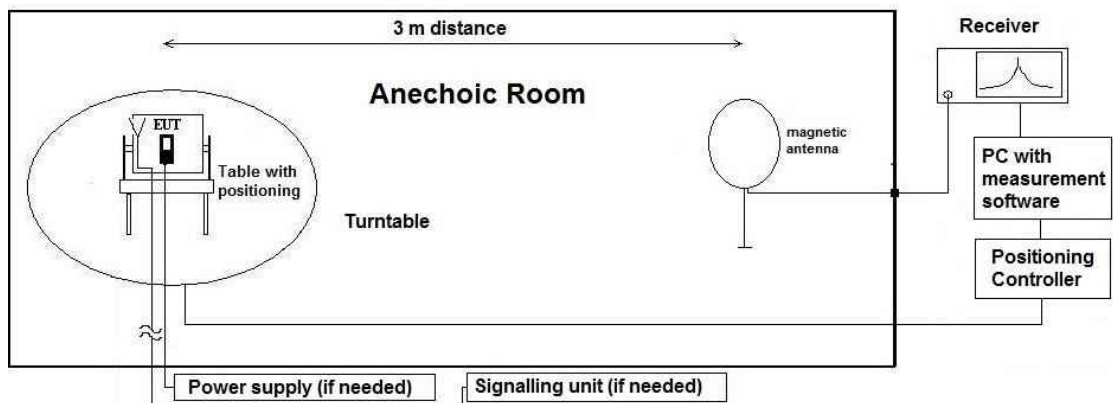
4.2 Radiated field strength emissions below 30 MHz

4.2.1 Description of the general test setup and methodology, see below example:

Evaluating the radiated field emissions are done first by an exploratory emission measurement and a final measurement for most critical frequencies determined.

The loop antenna was placed at 1 m height above ground plane and 3 m measurement distance from set-up for investigations. Because of reduced measurement distance, correction data were applied, as stated in chapter "General Limit - Radiated field strength emissions below 30 MHz". The tests are performed in the semi anechoic room recognized by the regulatory commission.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (step 90°, range 0° to 360°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT), the emission spectrum was recorded.

The loop antenna was moved at least to 2-perpendicular axes (antenna vector in direction of EUT and parallel to EUT) in order to maximize the emissions. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a data reduction table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by main-taining the EUT's worst-case operation mode, cable position, etc.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position).

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

Formula:

$$E_C = E_R + AF + C_L + D_F - G_A$$

$$M = L_T - E_C$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

4.2.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.2.3 Correction factors due to reduced meas. distance ($f < 30$ MHz):

The used correction factors when the measurement distance is reduced compared to regulatory measurement distance, are calculated according Extrapolation formulas valid for EUT's with maximum dimension of $0.625 \times \text{Lambda}$. Formula 2+3+4 as presented in ANSI C63.10, Chapter 6.4.4 are used for the calculations of proper extrapolation factors

Frequency Range	f [kHz/MHz]	Lambda [m]	Far-Field Point [m]	Distance Limit accord. 15.209 [m]	1st Condition (dmeas < Dnear-field)	2nd Condition (Limit distance bigger dnear-field)	Distance Correction accord. Formula
kHz	9	33333.33	5305.17	300	fulfilled	not fulfilled	-80.00
	10	30000.00	4774.65		fulfilled	not fulfilled	-80.00
	20	15000.00	2387.33		fulfilled	not fulfilled	-80.00
	30	10000.00	1591.55		fulfilled	not fulfilled	-80.00
	40	7500.00	1193.66		fulfilled	not fulfilled	-80.00
	50	6000.00	954.93		fulfilled	not fulfilled	-80.00
	60	5000.00	795.78		fulfilled	not fulfilled	-80.00
	70	4285.71	682.09		fulfilled	not fulfilled	-80.00
	80	3750.00	596.83		fulfilled	not fulfilled	-80.00
	90	3333.33	530.52		fulfilled	not fulfilled	-80.00
	100	3000.00	477.47		fulfilled	not fulfilled	-80.00
	125	2400.00	381.97		fulfilled	not fulfilled	-80.00
	200	1500.00	238.73		fulfilled	fulfilled	-78.02
	300	1000.00	159.16		fulfilled	fulfilled	-74.49
	400	750.00	119.37		fulfilled	fulfilled	-72.00
	490	612.24	97.44		fulfilled	fulfilled	-70.23
	500	600.00	95.49	30	fulfilled	not fulfilled	-40.00
	600	500.00	79.58		fulfilled	not fulfilled	-40.00
	700	428.57	68.21		fulfilled	not fulfilled	-40.00
	800	375.00	59.68		fulfilled	not fulfilled	-40.00
	900	333.33	53.05		fulfilled	not fulfilled	-40.00
MHz	1.00	300.00	47.75		fulfilled	not fulfilled	-40.00
	1.59	188.50	30.00		fulfilled	not fulfilled	-40.00
	2.00	150.00	23.87		fulfilled	fulfilled	-38.02
	3.00	100.00	15.92		fulfilled	fulfilled	-34.49
	4.00	75.00	11.94		fulfilled	fulfilled	-32.00
	5.00	60.00	9.55		fulfilled	fulfilled	-30.06
	6.00	50.00	7.96		fulfilled	fulfilled	-28.47
	7.00	42.86	6.82		fulfilled	fulfilled	-27.13
	8.00	37.50	5.97		fulfilled	fulfilled	-25.97
	9.00	33.33	5.31		fulfilled	fulfilled	-24.95
	10.00	30.00	4.77		fulfilled	fulfilled	-24.04
	10.60	28.30	4.50		fulfilled	fulfilled	-23.53
	11.00	27.27	4.34		fulfilled	fulfilled	-23.21
	12.00	25.00	3.98		fulfilled	fulfilled	-22.45
	13.56	22.12	3.52		fulfilled	fulfilled	-21.39
	15.00	20.00	3.18		fulfilled	fulfilled	-20.51
	15.92	18.85	3.00		fulfilled	fulfilled	-20.00
	17.00	17.65	2.81		not fulfilled	fulfilled	-20.00
	18.00	16.67	2.65		not fulfilled	fulfilled	-20.00
	20.00	15.00	2.39		not fulfilled	fulfilled	-20.00
	21.00	14.29	2.27		not fulfilled	fulfilled	-20.00
	23.00	13.04	2.08		not fulfilled	fulfilled	-20.00
	25.00	12.00	1.91		not fulfilled	fulfilled	-20.00
	27.00	11.11	1.77		not fulfilled	fulfilled	-20.00
	29.00	10.34	1.65		not fulfilled	fulfilled	-20.00
	30.00	10.00	1.59		not fulfilled	fulfilled	-20.00

4.2.4 Limit

Radiated emissions limits, (3 meters)					
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	Distance [m]	Detector	RBW [kHz]
0.009 – 0.09	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.09 – 0.11	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Quasi peak	0.2
0.11 – 0.15	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	0.2
0.15 – 0.49	2400 / f [kHz]	67.6 – 20Log(f) (kHz)	300	Pk & Avg	9
0.49 – 1.705	24000 / f [kHz]	87.6 – 20Log(f) (kHz)	30	Quasi peak	9
1.705 - 30	30	29.5	30	Quasi peak	9

*Remark: In Canada same limits apply, just unit reference is different

4.2.5 Result

Diagram	Channel	Mode	Maximum Level [$\text{dB}\mu\text{V}/\text{m}$] Frequency Range 0.009 – 30 MHz	Result
2.05	1	TX 13.56 MHz EUT standing	20.073	Passed
2.06	1	TXRX 13.56 MHz EUT standing	19.734	Passed

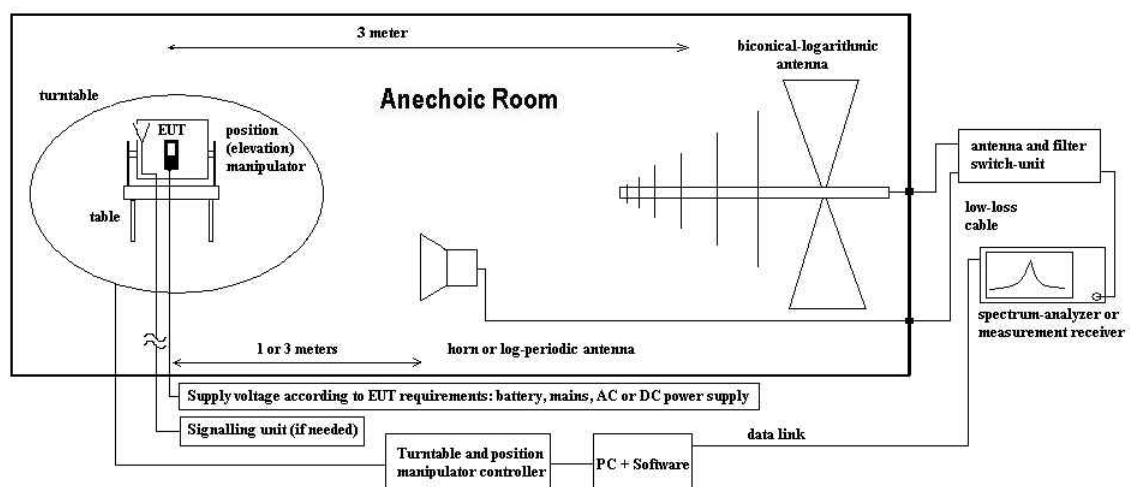
Remark: for more information and graphical plot see annex A1 **CETECOM_TR20_1_0094901T08a_A1**

4.3 Radiated field strength emissions 30 MHz – 1 GHz

4.3.1 Description of the general test setup and methodology, see below example:

Evaluating the emissions have to be done first by an exploratory emissions measurement and a final measurement for most critical frequencies. The tests are performed in a CISPR 16-1-4:2010 compliant semi anechoic room (SAR) and fully anechoic room (FAR) recognized by the regulatory commission. The measurement distance was set to 3 meter for frequencies up to 18 GHz and 2 meter above 18 GHz. A logarithmic periodic antenna is used for the frequency range 30 MHz to 1 GHz. Horn antennas are used for frequency range 1 GHz to 40 GHz. The EUT is aligned within 3 dB beam width of the measurement antenna with three orthogonal axis measurements on the EUT.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See *Tables Summary of Test Results* and *Summary of Test Methods* on page 6)

Exploratory, preliminary measurements

The EUT and its associated accessories are placed on a non-conductive position manipulator (tipping device) of 0.8 m height which is placed on the turntable. By rotating the turntable (range 0° to 360°, step 90°) and the EUT itself either on 3-orthogonal axis (portable equipment) or 2-orthogonal axis (defined operational position of EUT) the emission spectrum and its characteristics was recorded with an EMI-receiver, broadband antenna and software.

Measurement antenna: horizontal and vertical, heights: 1,0 m and 1,82 m as worst-case determined by an exploratory emission measurements. The results are documented in a diagram. Critical frequencies (low margin to limit) are saved within a table for further investigations. If various operating modes are supported, further investigations are made to find the worst-case of them. Also the interconnection cables and equipment position were varied in order to maximize the emissions.

Final measurement on critical frequencies

Based on the exploratory measurements, the most critical frequencies are re-measured by maintaining the EUT's worst-case operation mode, cable position, etc. either on 10m OATS or 3m semi-anechoic room.

First a frequency zoom around the critical frequency is done to locate the frequency more precisely. After this step, for all identified critical frequencies, the maximum peak was determined.

Following parameters were varied: the turntable angle continuously in the range 0 to 360 degree, the EUT itself either over 3-orthogonal axis (not defined usage position) or 2-orthogonal axis (defined usage position). The measurement antenna height between 1 m and 4 m.

On the determined worst-case position, a final measurement with necessary bandwidth and detector according standard has been carried out.

$$E_C = E_R + AF + C_L + D_F - G_A \quad (1)$$

$$M = L_T - E_C \quad (2)$$

AF = Antenna factor

C_L = Cable loss

D_F = Distance correction factor (if used)

E_C = Electrical field – corrected value

E_R = Receiver reading

G_A = Gain of pre-amplifier (if used)

L_T = Limit

M = Margin

All units are dB-units, positive margin means value is below limit.

4.3.2 Measurement Location

Test site	120901 - SAC - Radiated Emission <1GHz
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4.3.3 Limit

Radiated emissions limits, (3 meters)				
Frequency Range [MHz]	Limit [$\mu\text{V}/\text{m}$]	Limit [$\text{dB}\mu\text{V}/\text{m}$]	Detector	RBW / VBW [kHz]
30 - 88	100	40.0	Quasi peak	100 / 300
88 - 216	150	43.5	Quasi peak	100 / 300
216 - 960	200	46.0	Quasi peak	100 / 300
960 - 1000	500	54.0	Quasi peak	100 / 300

4.3.4 Result

Diagram	Channel	Mode	Maximum Level [$\text{dB}\mu\text{V}/\text{m}$] Frequency Range 0.009 – 30 MHz	Result
3.01	1	Op. 1 standingn	No peaks found, noise level 35	PASSED
3.02	1	Op. 2 standing	No peaks found, noise level 35	PASSED

Remark: for more information and graphical plot see annex A1 **CETECOM_TR20_1_0094901T08a_A1**

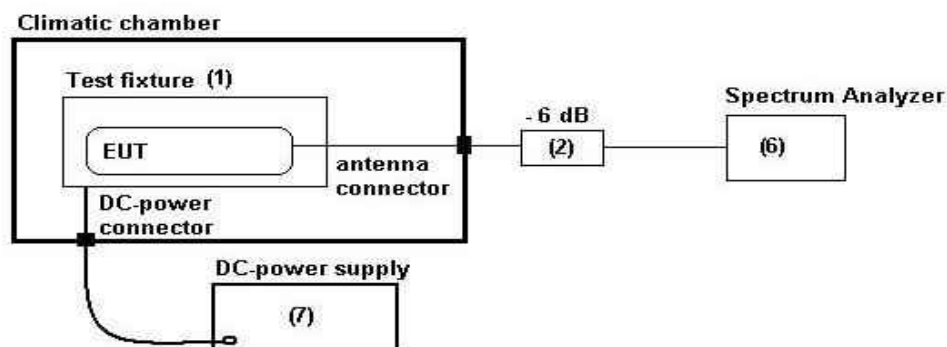
4.4 Occupied Channel Bandwidth 99%

4.4.1 Description of the general test setup and methodology, see below example:

The EUT's RF-signal is coupled out by a suitable antenna coupling connector (1). The signal is then directly connected to the spectrum – analyzer (4) for specific RF-measurements. The specific attenuation losses for both signal paths/branches are determined prior to the measurement within a set-up calibration. These are then taken into account by correcting the measurement readings on the spectrum-analyzer.

In case an external connector is not available, the coupling unit consists of a near-field antenna which is directly connected to the spectrum analyser. The power level calibration of the spectrum analyser is related to the power levels (field strengths) of the carrier determined in the anechoic-chamber.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:
(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

Measurement is made using Rohde & Schwarz TS8997 test system.

4.4.2 Measurement Location

Test site	120910 - Radio Laboratory 1 (TS 8997)
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4.4.3 Limit

When the occupied bandwidth limit is not stated in the applicable reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

4.4.4 Result

Mode	Channel	Frequency [MHz]	99% Occupied bandwidth [kHz]
Op. 1	1	13.56	1.0897
Op. 2	1	13.56	1.1137

Remark: for more information and graphical plot see annex A1CETECOM_TR20_1_0094901T08a_A1

4.5 Frequency stability

4.5.1 Description of the general test setup and methodology, see below example:

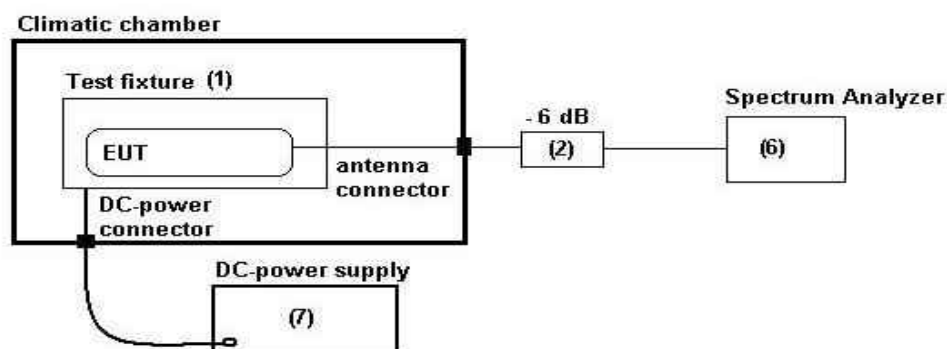
A sniffer antenna acts like a coupling antenna for measuring the fundamental frequency. This is placed at about 20cm away from the equipment. Also connecting cables at the equipment are avoided on the extent possible in order not to degrade the resonance frequency of the equipment and integral antenna.

If the equipment is capable of producing an un-modulated carrier then a trace with max-hold function was recorded. The maximum peak within the span was found, then the frequency deviation was recorded with the build-in frequency counter within the spectrum-analyze. The maximum resolution was chosen on the settings.

The frequency deviation was recorded at switching on point of the equipment and on 2 minutes, 5 minutes and 10 minutes after at in accordance with ANSI 63.10: 2020, Chapter 6.8

All measurements data are enclosed in annex measurements. Here only maximum frequency error is reported.

Schematic:



Testing method:

The measurement is made according to relevant reference clauses:

(See Tables *Summary of Test Results* and *Summary of Test Methods* on page 6)

4.5.2 Measurement Location

Test site	120911 - Radio Laboratory 2
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4.5.3 Limit

Frequency Range [MHz]	Frequency tolerance			Remarks
	%	[ppm]	[Hz]	
13.553 – 13.567	±0.01	±100	±1355.99207	For voltage variation
13.553 – 13.567	±0.01	±100	±1355.99743	For temperature variation

Remark: for more information and graphical plot see annex A1CETECOM_TR20_1_0094901T08a_A1

4.5.4 Results

4.5.4.1 Results for voltage variation

DC power supply					
Nominal condition					
Vnom = 13.5 V Tnom = 21°C	13.55992070	MHz	Limit-> 100ppm:	1355.99207	Hz
			f _{MIN} :	13.55856471	MHz
			f _{MAX} :	13.56127669	MHz
Extreme conditions					
Voltage		Frequency measured	Values for Frequency Error		
[V]		[MHz]	[Hz]	[%]	[ppm]
V _{MAX}	36.00	13.5599114	-9	0.000069	0.69
	32.67	13.5599196	-1	0.000008	0.08
	29.33	13.5599169	-4	0.000028	0.28
	26.00	13.5599169	-4	0.000028	0.28
	22.67	13.5599150	-6	0.000042	0.42
	19.33	13.5599230	2	-0.000017	-0.17
	16.00	13.5599222	2	-0.000011	-0.11
	12.67	13.5599228	2	-0.000015	-0.15
	9.33	13.5599215	1	-0.000006	-0.06
V _{MIN}	6.00	13.5599198	-1	0.000007	0.07

Remark: for more information and graphical plot see annex A1CETECOM_TR20_1_0094901T08a_A1

Verdict: Passed

4.5.4.2 Results for temperature variation

Extreme conditions									
Temperature	Measurement period after power-up the EUT	Frequency measured	Values for Frequency Error			Abs. Maximum Value		Absolute Maximum value	Verdict
			[Hz]	[%]	[ppm]				
Tmax=75°C	on StartUp	13.5599658	-8.50	-0.000063	-0.63	2.51	5.01	Pass	
	2 Minutes	13.5599403	-34.00	-0.000251	-2.51				
	5 Minutes	13.5599616	-12.70	-0.000094	-0.94				
	10 Minutes	13.5599909	16.60	0.000122	1.22				
T=70°C	on StartUp	13.5599208	-53.50	-0.000395	-3.95	3.95			
	2 Minutes	13.5599381	-36.20	-0.000267	-2.67				
	5 Minutes	13.5599568	-17.50	-0.000129	-1.29				
	10 Minutes	13.5599813	7.00	0.000052	0.52				
T=60°C	on StartUp	13.5599073	-67.00	-0.000494	-4.94	4.94			
	2 Minutes	13.5599209	-53.40	-0.000394	-3.94				
	5 Minutes	13.5599275	-46.80	-0.000345	-3.45				
	10 Minutes	13.5599413	-33.00	-0.000243	-2.43				
T=50°C	on StartUp	13.5599084	-65.90	-0.000486	-4.86	5.01			
	2 Minutes	13.5599064	-67.90	-0.000501	-5.01				
	5 Minutes	13.5599085	-65.80	-0.000485	-4.85				
	10 Minutes	13.5599138	-60.50	-0.000446	-4.46				
T=40°C	on StartUp	13.5599257	-48.60	-0.000358	-3.58	4.98			
	2 Minutes	13.5599138	-60.50	-0.000446	-4.46				
	5 Minutes	13.5599089	-65.40	-0.000482	-4.82				
	10 Minutes	13.5599068	-67.50	-0.000498	-4.98				
T=30°C	on StartUp	13.5599189	-55.40	-0.000409	-4.09	4.60			
	2 Minutes	13.5599144	-59.90	-0.000442	-4.42				
	5 Minutes	13.5599128	-61.50	-0.000454	-4.54				
	10 Minutes	13.5599119	-62.40	-0.000460	-4.60				
T=20°C	on StartUp	13.5599831	8.80	0.000065	0.65	2.26			
	2 Minutes	13.5599651	-9.20	-0.000068	-0.68				
	5 Minutes	13.5599539	-20.40	-0.000150	-1.50				
	10 Minutes	13.5599437	-30.60	-0.000226	-2.26				
T=10°C	StartUp	13.5600113	37.00	0.000273	2.73	2.73			
	2 Minutes	13.5599968	22.50	0.000166	1.66				
	5 Minutes	13.5599863	12.00	0.000088	0.88				
	10 Minutes	13.5599760	1.70	0.000013	0.13				
T=0°C	StartUp	13.5600324	58.10	0.000428	4.28	4.28			
	2 Minutes	13.5600240	49.70	0.000367	3.67				
	5 Minutes	13.5600157	41.40	0.000305	3.05				
	10 Minutes	13.5600063	32.00	0.000236	2.36				
T=-10°C	StartUp	13.5600296	55.30	0.000408	4.08	4.31			
	2 Minutes	13.5600327	58.40	0.000431	4.31				
	5 Minutes	13.5600311	56.80	0.000419	4.19				
	10 Minutes	13.5600271	52.80	0.000389	3.89				
T=-20°C	StartUp	13.5600270	52.70	0.000389	3.89	4.34			
	2 Minutes	13.5600244	50.10	0.000369	3.69				
	5 Minutes	13.5600300	55.70	0.000411	4.11				
	10 Minutes	13.5600331	58.80	0.000434	4.34				
Tmin=-30°C	StartUp	13.5599506	-23.70	-0.000175	-1.75	3.38			
	2 Minutes	13.5599907	16.40	0.000121	1.21				
	5 Minutes	13.5600078	33.50	0.000247	2.47				
	10 Minutes	13.5600202	45.90	0.000338	3.38				

Remark: for more information and graphical plot see annex A1CETECOM_TR20_1_0094901T08a_A1

4.6 Results from external laboratory

None	-
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4.7 Opinions and interpretations

None	-
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4.8 List of abbreviations

None	-
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5 Equipment lists

ID	Description	Manufacturer	SerNo	Cal due date
	120901 - SAC - Radiated Emission <1GHz			2025-Jul-21
20574	Biconilog Hybrid Antenna BTA-L	Frankonia GmbH	980026L	2022-May-03
20487	CETECOM Semi Anechoic Chamber < 1GHz	ETS-Lindgren GmbH	-	2025-Jul-15
20341	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	81650455	2022-May-25
20620	EMI Test Receiver ESU26	Rohde & Schwarz Messgerätebau GmbH	100362	2022-May-21
20482	filter matrix Filter matrix SAR 1	CETECOM GmbH	-	*1a
25038	Loop Antenna HFH2-Z2	Rohde & Schwarz Messgerätebau GmbH	879824/13	2022-Apr-07
20885	Power Supply EA3632A	Agilent Technologies Deutschland GmbH	75305850	Pre-m
	120911 - Radio Laboratory 2			n/a
20457	DC-Power supply, 0-5A EA-3013 S	EA Elektro-Automatik GmbH & Co. KG	9624680	Pre-m
20468	Digital Multimeter Fluke 112	Fluke Deutschland GmbH	90090455	2024-Jun-01
20431	Model 7405 Near-Field Probe Set	EMCO Elektronik GmbH	9305-2457	Pre-m
20690	Spectrum Analyzer FSU	Rohde & Schwarz Messgerätebau GmbH	100302/026	2023-May-20
20869	VT4002 Klimaschrank	Vötsch Industrietechnik GmbH, a schunk company	521/79152	2021-Oct-06

Remarks: *1a: calibrated with system 120901 - SAC
 *1b: calibrated with system 120904 - FAC1
 *1c: calibrated with system 120907 – FAC2
 Pre-m: Check before starting the measurement

6 Measurement Uncertainty valid for conducted/radiated measurements

The reported uncertainties are calculated based on the standard uncertainty multiplied with the appropriate coverage factor k , such that a confidence level of approximately 95% is achieved. For uncertainty determination, each component used in the concrete measurement set-up was taken in account and its contribution to the overall uncertainty according its statistical distribution calculated.

RF-Measurement	Reference	Frequency range	Calculated uncertainty based on a confidence level of 95%							Remarks
Conducted emissions (U _{CISPR})	-	9 kHz - 150 kHz 150 kHz - 30 MHz	4.0 dB 3.6 dB							-
Power Output radiated	-	30 MHz - 4 GHz	3.17 dB							Substitution method
Power Output conducted	-	Set-up No.	Cel-C1	Cel-C2	BT1	W1	W2	--	-	
		9 kHz - 12.75 GHz	N/A	0.60	0.7	0.25	N/A	--		
		12.75 GHz - 26.5 GHz	N/A	0.82	--	N/A	N/A	--		
Conducted emissions on RF-port	-	9 kHz - 2.8 GHz	0.70	N/A	0.70	N/A	0.69	--	N/A - not applicable	
		2.8 GHz - 12.75 GHz	1.48	N/A	1.51	N/A	1.43	--		
		12.75 GHz – 18 GHz	1.81	N/A	1.83	N/A	1.77	--		
		18 GHz - 26.5 GHz	1.83	N/A	1.85	N/A	1.79	--		
Occupied bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
			1.0 dB							Power
Emission bandwidth	-	9 kHz - 4 GHz	0.1272 ppm (Delta Marker)							Frequency error
	-		See above: 0.70 dB							Power
Frequency stability	-	9 kHz - 20 GHz	0.0636 ppm							-
Radiated emissions Enclosure	-	150 kHz - 30 MHz	5.01dB							Magnetic field strength
		30 MHz - 1 GHz	5.83 dB							Electrical Field strength
		1 GHz - 18 GHz	4.91 dB							
		18-26.5 GHz	5.06 dB							

7 Versions of test reports (change history)

Version	Applied changes	Date of release
--	Initial release	2021-Sep-06
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End Of Test Report